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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
SYSTEM DESCRIPTION DOCUMENT REVISION HISTORY

1. SDD Title
Naval Spent Nuclear Fuel Disposal Container System Description Document

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3. Revision	4. Description of Revision
00	Initial Issue This document is a complete revision of the superseded BBA000000-01717-1705-00006. The document incorporates changes to the "Monitored Geologic Repository Requirements Document," including switching traceability to the "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada." This revision incorporates the "Classification of the MGR Naval Spent Nuclear Fuel Disposal Container System." This revision incorporates the revision to the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container." Changes have been included for the system to comply with management direction put into effect via the "Monitored Geologic Repository Project Description Document."
01	Issued This is a complete revision. Deleted Criteria 1.2.4.1, 1.2.4.2, 1.2.6.3 through 1.2.6.6, and Sections 1.4.1 and 1.4.2, as they were deemed unnecessary by management decision. Added Section 2 (Design Description) to support Site Recommendation. Revised Criteria 1.2.1.4, 1.2.2.1.5, 1.2.2.1.7, 1.2.2.1.12, and 1.2.2.1.13 as a result of updated design information. Added Criteria 1.2.1.20, 1.2.1.21, 1.2.1.22, and 1.2.4.7 as a result of new design information. Revised format to eliminate two-volume configuration in compliance with the revised development plan.
01 ICN 01	Added Criterion 1.2.1.23 and revised Criterion 1.2.3.1 to support the Flexible Operations Concept of the MGR. Revised the Quality Assurance statement to include the relevant Technical Work Plan. Added Issue 16 to Appendix D. Updated references "Monitored Geologic Repository Project Description Document" to Rev 02 ICN 02, "Technical Reports" to Rev 02, and "Waste package Design Sensitivity Report" to Rev 01. Changes made to this document as part of this ICN are indicated by a change bar in the right margin.

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SUMMARY

The Naval Spent Nuclear Fuel Disposal Container System supports the confinement and isolation of waste within the Engineered Barrier System of the Monitored Geologic Repository (MGR). Disposal containers/waste packages are loaded and sealed in the surface waste handling facilities, transferred underground through the access drifts using a rail mounted transporter, and emplaced in emplacement drifts. The Naval Spent Nuclear Fuel Disposal Container System provides long term confinement of the naval spent nuclear fuel (SNF) placed within the disposal containers, and withstands the loading, transfer, emplacement, and retrieval operations.

The Naval Spent Nuclear Fuel Disposal Container System provides containment of waste for a designated period of time and limits radionuclide release thereafter. The waste package maintains the waste in a designated configuration, withstands maximum credible handling and rockfall loads, limits the waste form temperature after emplacement, resists corrosion in the expected handling and repository environments, and provides containment of waste in the event of an accident.

Each naval SNF disposal container will hold a single naval SNF canister. There will be approximately 300 naval SNF canisters, composed of long and short canisters. The disposal container will include outer and inner cylinder walls and lids. An exterior label will provide a means by which to identify a disposal container and its contents.

Different materials will be selected for the waste package inner and outer cylinders. The two metal cylinders, in combination with the Emplacement Drift System, drip shield, and the natural barrier will support the design philosophy of defense-in-depth. The use of materials with different properties prevents a single mode failure from breaching the waste package. The inner cylinder and inner cylinder lids will be constructed of stainless steel while the outer cylinder and outer cylinder lids will be made of high-nickel alloy.

The Naval Spent Nuclear Fuel Disposal Container System interfaces with the emplacement drift environment and the internal waste by transferring heat from the canisters to the external environment and by protecting the canisters and their contents from damage/degradation by the external environment. The disposal container also interfaces with the canisters by limiting access of moderator and oxidizing agents to the waste. The waste package interfaces with the Emplacement Drift System's emplacement drift pallets upon which the waste packages are placed. The disposal container/waste package interfaces with the Canister Transfer System, Carrier/Cask Handling System, Waste Emplacement/Retrieval System, Disposal Container Handling System, and Waste Package Remediation System during loading, handling, transfer, emplacement, retrieval, and remediation of the disposal container/waste package.

QUALITY ASSURANCE

The quality assurance (QA) program applies to the development of this document. The activity evaluation for work package number 11612125N4, included in "Technical Work Plan for: Waste Package Design Description for SR" (p. 36), has determined the development of this document is subject to "Quality Assurance Requirements and Description" requirements. Electronic management of data is also controlled in accordance with "Technical Work Plan for: Waste Package Design Description for SR." This document was developed in accordance with AP-3.11Q, "Technical Reports."

1. SYSTEM FUNCTIONS AND DESIGN CRITERIA

The functions and design criteria for the Naval Spent Nuclear Fuel Disposal Container System are identified in the following sections. Throughout this document, the term "disposal container" is used to indicate the Naval Spent Nuclear Fuel Disposal Container System and the suite of individual disposal containers designed for naval SNF canisters. The system architecture and classification are provided in Appendix B.

The term "disposal container" means the container cylinders and any integral structures (spacers, lifting features, absorbent materials, etc.). The term "waste package" means a disposal container that is loaded with a naval SNF canister, sealed by the design methods, and is tested and accepted, per the Disposal Container Handling System.

It should be noted that the disposal container does not provide criticality control for the naval SNF. Criticality control for naval SNF is maintained by the naval SNF canister and naval SNF.

To address the term "breach" in a quantified manner, threshold limits for failure per ASME (American Society of Mechanical Engineers) code are to be used. Throughout this document when the term "breach" is referred to in a function or criterion, the following applies: During normal handling operations, breach has occurred, analytically, when Subsection NB 3200 of the "1995 ASME Boiler and Pressure Vessel Code" limits of stress intensity for the stress categories are exceeded. (A later code edition acceptable to the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy may be used in the final design.) For "Level D" (design basis event) conditions, breach has occurred, analytically, when 0.9 of the ultimate tensile strength is exceeded through the outer barrier thickness.

1.1 SYSTEM FUNCTIONS

1.1.1 The waste package contains canistered, naval SNF within its boundary until it is breached.

1.1.2 The waste package restricts the transport of radionuclides to the outside of the waste package's boundary after it is breached.

1.1.3 The disposal container in conjunction with the naval SNF canister provides criticality control during and after loading.

1.1.4 The waste package accommodates the thermal loading strategy for the repository.

1.1.5 The waste package provides identification of individual disposal containers and their contents.

1.1.6 The waste package provides safety for personnel, equipment, and the environment.

1.1.7 The waste package prevents adverse reactions involving the naval SNF during handling operations.

1.1.8 The disposal container/waste package withstands loading, handling, sealing, transfer, emplacement, and retrieval loads.

1.1.9 The waste package withstands the emplacement drift environment for the regulatory period of the repository.

1.1.10 The waste package provides conditions needed to maintain the physical and chemical stability of the naval SNF.

1.1.11 The waste package minimizes the mobilization of radionuclides.

1.1.12 The waste package allows heat transfer between the waste form and the environment external to the waste package.

1.1.13 The disposal container/waste package accommodates handling, sealing, loading, emplacement, and retrieval operations.

1.1.14 The disposal container/waste package outer surface facilitates decontamination.

1.2 SYSTEM DESIGN CRITERIA

This section presents the design criteria for the system. Each criterion in this section has a corresponding Criterion Basis Statement in Appendix A that describes the need for the criterion as well as a basis for the performance parameters imposed by the criterion. Each criterion in this section also contains bracketed traces indicating traceability, as applicable, to the functions (F) in Section 1.1, the "Monitored Geologic Repository Requirements Document" (MGR RD), and "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada." In anticipation of the interim guidance being promulgated as a Code of Federal Regulations, it will be referred to as "10 CFR 63" in this system description document. For the applicable version of the codes, standards, and regulatory documents, refer to Appendix E.

1.2.1 System Performance Criteria

1.2.1.1 The disposal container/waste package shall be designed, in conjunction with the Emplacement Drift System and the natural barrier, such that the expected annual dose to the average member of the critical group shall not exceed 25 mrem total effective dose equivalent at any time during the first 10,000 years after permanent closure, as a result of radioactive materials released from the geologic repository.

[F 1.1.1][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.1.2 The disposal container shall accommodate short (185.63 in.) and long (210.63 in.) naval SNF canisters made of 316L stainless steel.

[F 1.1.1, 1.1.2][MGR RD 3.2.B, 3.2.C]

1.2.1.3 The disposal container shall consist of two cylinders; an inner cylinder that is a minimum 50 mm thick stainless steel (alloy 316 NG), and an outer cylinder that is a minimum 20 mm thick alloy 22 material.

[F 1.1.1, 1.1.2][MGR RD 3.1.C][10 CFR 63.113(a)]

1.2.1.4 The disposal container shall be designed to accommodate heat fluxes on the surface of the naval SNF canister in accordance with Table 1.

Table 1. Maximum Heat Flux vs. Temperature

Temperature (°C)	Heat Flux (kW/m^2)
50	0.600
131	0.535
197	0.491
216	0.224
TBD-429	TBD-429

[F 1.1.4, 1.1.11, 1.1.12][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.1.5 The disposal container/waste package shall prevent the breach of the naval SNF canister during normal handling operations.

[F 1.1.7, 1.1.10][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.113(b)]

1.2.1.6 The disposal container/waste package shall be designed to support/allow retrieval up to 300 years after the start of emplacement operations.

[F 1.1.8, 1.1.13][MGR RD 3.1.C, 3.1.G, 3.2.H][10 CFR 63.111(e)(1)]

1.2.1.7 The disposal container, excluding the labels, shall have an external surface finish Roughness Average of 250 μin (6.35 μm) or less.

[F 1.1.14][MGR RD 3.1.C][10 CFR 63.112(e)(2)]

1.2.1.8 The disposal container shall have all external surfaces (surfaces exposed to the external environment after closing and sealing a disposal container) accessible for visual inspection and decontamination (e.g., no blind holes).

[F 1.1.14][MGR RD 3.1.C][10 CFR 63.112(e)(2)]

1.2.1.9 The disposal container/waste package shall have a label or other means of identification with a unique package identifier and contents information.

[F 1.1.5][MGR RD 3.1.B, 3.1.C, 3.3.K][10 CFR 63.112(e)(2), 63.78]

1.2.1.10 All labels (or other means of identification) applied to the disposal container shall not impair the integrity of the waste package.

[F 1.1.5][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.1.11 All information contained on all labels (or other means of identification) applied to the disposal container/waste package shall be legible or read by remote means until permanent closure of the repository.

[F 1.1.5][MGR RD 3.1.C, 3.1.D, 3.3.K][10 CFR 63.112(e)(2), 63.78]

1.2.1.12 Lifting features of the disposal container/waste package shall be designed for three times the maximum weight of the waste package without generating a combined shear stress or maximum tensile stress in excess of the corresponding minimum tensile yield strength of the materials of construction.

[F 1.1.8, 1.1.13][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.111(e)(2), 63.112(e)(8)]

1.2.1.13 The lifting features of the disposal container/waste package shall be designed for five times the weight of the waste package without exceeding the ultimate tensile strength of the materials of construction.

[F 1.1.8][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(2), 63.112(e)(8)]

1.2.1.14 Reserved

1.2.1.15 The waste package shall withstand transfer, emplacement, and retrieval operations without breaching.

[F 1.1.8, 1.1.13][MGR RD 3.1.C][10 CFR 63.111(a)(2)]

1.2.1.16 Reserved

1.2.1.17 The disposal container/waste package shall be constructed of non-combustible and heat resistant materials only.

[F 1.1.1, 1.1.6, 1.1.12][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.1.18 Disposal container/waste package materials shall exclude the use of explosive or pyrophoric materials.

[F 1.1.1, 1.1.6, 1.1.12][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.1.19 Disposal container/waste package materials shall exclude the use of free liquids.

[F 1.1.1, 1.1.10]

1.2.1.20 Manufacturing residual tensile stresses shall be maintained below 10 percent of yield strength of the outer barrier material for a depth of (TBD-235) from the outer surface.

[F 1.1.2, 1.1.6]

1.2.1.21 Static loads in the outer barrier shall not produce tensile stresses above 10 percent of yield strength of the outer barrier material at the interface with the emplacement pallet.

[F 1.1.2, 1.1.6]

1.2.1.22 Tensile stresses in the outer barrier shall be maintained below yield strength of the outer barrier material during a seismic event.

[F 1.1.2, 1.1.6]

1.2.1.23 The waste package, including any internal structures, shall be designed to include sufficient shielding to protect the waste package materials (in the as-emplaced condition) from radiation enhanced corrosion.

[F 1.1.1, 1.1.2]

1.2.2 Safety Criteria

1.2.2.1 Nuclear Safety Criteria

1.2.2.1.1 During the preclosure period, while in a horizontal orientation, the waste package shall be designed to withstand a 6 MT (13,230 lb) (TBV-245) rock falling 3.3 m (10.8 ft) (TBV-245) onto the side of the waste package without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.2 During the preclosure period, the disposal container/waste package shall be designed to withstand (while in a vertical orientation) a 2.3 MT (5,100 lb) (TBV-245) spherical object falling 2 m (6.6 ft) (TBV-245) onto the end of the waste package without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.3 During the preclosure period, the disposal container/waste package shall be designed to withstand (while in a vertical orientation) a drop from a height of 2 m (6.6 ft) (TBV-245) onto a flat, unyielding surface without breaching. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.4 During the preclosure period, the disposal container/waste package shall be designed to withstand (while in a horizontal orientation) a drop from a height of 2.4 m (7.9 ft) (TBV-245) onto a flat, unyielding surface without breaching. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.5 During the preclosure period, the waste package shall be designed to withstand (while in a horizontal orientation) the stress resulting from a drop of the waste package, with the emplacement pallet, from a height of (TBD-235) onto an essentially unyielding surface without breaching by puncture. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.6 During the preclosure period, the waste package shall be designed to withstand a tip over from a vertical position with slap down onto a flat, unyielding surface without breaching. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.7 The waste package shall be designed to withstand a Frequency Category 2 Design Basis Earthquake during the preclosure period (TBV-1246). Both vibratory ground motion and fault displacement of the Frequency Category 2 Design Basis Earthquake must be considered, taking credit, as appropriate, for interfacing systems that alter or mitigate the effect of the design basis earthquake on the waste package. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.8 During the preclosure period, the waste package shall be designed to withstand the impact of a 0.5 kg (1.1 lb) (TBV-245) missile (modeled as a 1 cm diameter, 5 cm long valve stem) travelling at 5.7 m per second (18.7 ft/sec) (TBV-245) without breaching. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.9 During the preclosure period, the waste package shall be designed to withstand, without breaching, the maximum impact resulting from a transporter runaway, derailment, and impact at a speed of 63 km/hr (39 mi/hr) (TBV-245), taking credit, as appropriate, for interfacing systems that prevent derailment and impact with walls of the repository drifts or mitigate the impact on the waste package. (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.10 During the preclosure period, the waste package shall be designed to withstand, without breaching, the maximum internal pressure of (TBD-235) at an ambient temperature less than or equal to (TBD-235) as generated by (TBD-235). (TBV-245)

[F 1.1.1, 1.1.6, 1.1.9][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.11 The waste package/disposal container shall be designed to withstand the hypothetical fire criteria defined in 10 CFR 71 ("Packaging and Transportation of Radioactive Material"), Section 73(c)(4). (TBV-245)

[F 1.1.10][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.12 During the preclosure period, the disposal container/waste package shall be designed in coordination with the naval SNF canisters such that the effective multiplication factor (k_{eff}) is less than or equal to 0.95 under assumed accident conditions considering allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation. (TBV-245)

[F 1.1.3][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(6), 63.112(e)(8)]

1.2.2.1.13 During the postclosure period, the naval SNF waste package shall be designed such that nuclear criticality shall not occur for naval SNF (k_{eff} is less than 0.95 for all credible configurations).

[F 1.1.3][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.2.2 Non-nuclear Safety Criteria

Non-nuclear safety criteria for this system will be identified in a later revision, as necessary.

1.2.3 System Environment Criteria

1.2.3.1 The waste package shall meet all performance requirements during and after exposure to the emplacement drift environments identified in Table 2 (TBV-4743) (TBD-234) and Table 3. (TBD-276)

Table 2. Emplacement Drift External Environment

Environment	Range	Duration/Frequency of Occurrence
Microbe Concentration	0 to 10^{14} per year per meter of drift (TBV-4743)	10,000 years
pH	7 - 11	10,000 years
Colloid Concentration	8×10^{-6} to 6×10^{-5} mg/ml (TBV-4743)	10,000 years
Temperature	TBD-234	TBD-234
Humidity	0 - 95%	10,000 years
Radiation	TBD-234	TBD-234
Water Seepage	4.6 mm/yr 12.2 mm/yr 17.8 mm/yr	To year 2,600 From year 2,600 to year 3,000 From year 3,000 to year 12,000
TBD	TBD-234	TBD-234

Table 3. Induced/Handling External Environments

Environment	Range	Duration/Frequency of Occurrence
Vibration	TBD-276	TBD-276
Shock	TBD-276	TBD-276
Acceleration	TBD-276	TBD-276
TBD	TBD-276	TBD-276

[F 1.1.9][MGR RD 3.1.C, 3.4.2.C][10 CFR 63.113(b)]

1.2.4 System Interfacing Criteria

1.2.4.1 Disposal container design shall reduce the dose rate at all external surfaces of a waste package to (TBD-3764). This criterion identifies a disposal container interface with the Disposal Container Handling System, the Waste Emplacement/Retrieval System, and the Performance Confirmation Emplacement Drift Monitoring System.

[F 1.1.6, 1.1.13][MGR RD 3.1.B, 3.1.G]

1.2.4.2 The waste package shall be designed to have a maximum thermal output of 11.8 kW.

[F 1.1.4][MGR RD 3.2.F]

1.2.4.3 The quantity of waste forms disposed of in this suite of disposal containers shall total approximately 65 MTHM.

[F 1.1.1, 1.1.4][MGR RD 3.1.A, 3.2.A, 3.2.B]

1.2.4.4 The disposal container shall be designed for loading and sealing in a vertical orientation. This criterion identifies the primary disposal container interface with the Canister Transfer System and the Disposal Container Handling System.

[F 1.1.13]

1.2.4.5 The disposal container/waste package shall be designed to be handled while in the horizontal orientation, the vertical orientation, and when the disposal container/waste package is transitioning between the horizontal and vertical position. This criterion identifies the primary disposal container interface with the Disposal Container Handling System and the Waste Emplacement/Retrieval System.

[F 1.1.13]

1.2.4.6 The disposal container/waste package shall be designed to support required welding times. This criterion identifies a primary disposal container interface with the Disposal Container Handling System.

[F 1.1.13]

1.2.4.7 The system shall be designed in accordance with the interface agreements defined in "U.S. Department of Energy Spent Nuclear Fuel to the Monitored Geologic Repository for Mechanical and Envelope Interfaces," Volume 1 of "Integrated Interface Control Document."

[F 1.1.13]

1.2.5 Operational Criteria

Operational criteria for this system will be identified in a later revision, if necessary.

1.2.6 Codes and Standards Criteria

1.2.6.1 The system shall be designed in accordance with applicable sections of "1995 ASME Boiler and Pressure Vessel Code" (Section III, Division 1, Subsection NG-1995).

[MGR RD 3.3.A]

1.2.6.2 The system shall be designed in accordance with applicable sections of "1995 ASME Boiler and Pressure Vessel Code" (Section III, Division 1, Subsection NB-1995).

[MGR RD 3.3.A]

1.3 SUBSYSTEM DESIGN CRITERIA

There are no subsystem design criteria for this system.

1.4 CONFORMANCE VERIFICATION

This section will be provided in a future revision.

2. DESIGN DESCRIPTION

Section 2 of this System Description Document (SDD) summarizes information that is contained in other references. By assembling system specific information contained elsewhere (i.e., analyses, technical reports, etc.), Section 2 provides insight into the current state of the design of this system. However, due to the nature of design development, the information contained in this section will continue to change as the design matures.

2.1 SYSTEM DESIGN SUMMARY

The Naval Spent Nuclear Fuel disposal containers are designed to accept naval SNF canisters. There are two canister designs: a short canister design and a long canister design. Each naval disposal container is designed to hold a single naval spent nuclear fuel canister. The design of the naval SNF canister as well as its expected performance has been provided to the Yucca Mountain Site Characterization Office. The naval SNF disposal container has been designed based on the information received from the Naval Nuclear Propulsion Program. This section describes only the design of the naval SNF long disposal container because it is greater in length and weight than the naval SNF short disposal container (see note below).

The naval SNF long disposal container consists of two right-circular cylinders, hereafter called shells. It is comprised of two shells, an inner shell of stainless steel that provides structural support and an outer shell of high-nickel alloy that provides a corrosion-resistant barrier. The inner structural shell is inserted inside the outer corrosion-resistant shell. There are two lower lids that are welded to the shells at the time of fabrication. There are three upper lids that are welded in place after the disposal containers are loaded with the appropriate waste forms (reference "Design Analysis for the Naval SNF Waste Package," Section 6).

NOTE: For Site Recommendation, a set of the detailed designs has been explicitly evaluated to ensure design criteria are met. Through a sensitivity analysis, it was decided which disposal container designs best represent the array of design configurations and waste forms. The analysis also considered which of the design criteria would be satisfied by those representative designs. The analysis (reference "Waste Package Design Sensitivity Report," Section 5) resulted in the selection of four disposal container designs as adequate to jointly demonstrate compliance with design criteria for Site Recommendation:

- 21-PWR Absorber Plate
- 44-BWR
- 5-defense high-level waste (DHLW)/U.S. Department of Energy (DOE) SNF short
- naval SNF long

For criteria that apply to multiple designs, a decision may be made to evaluate just one of the four designs to demonstrate the methodology (reference "Waste Package Design Sensitivity Report," Section 6). The design and design criteria selected for Site Recommendation are provided in Section 2.5. More complete design information will be provided for all waste package designs as a part of the licensing process.

2.2 DESIGN ASSUMPTIONS

This section lists the assumptions used in the design of the naval SNF long disposal container that are provided for information only. Rationale statements are provided in the document referenced after each assumption.

2.2.1 Source Term

2.2.1.1 Photon and Neutron Currents

The photon and neutron currents at 2 years after shutdown are assumed to bound the dose rates on the waste package external surfaces. This assumption applies to Criterion 1.2.4.1 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2 Structural

2.2.2.1 Temperature Dependent Material Properties

Room-temperature (20 degrees C) material properties are assumed for all materials. Some of the temperature-dependent material properties are not available for SB-575 N06022 (Alloy 22), SA-240 316NG (316NG stainless steel), and SA-240 S31603 (316L SS). This assumption applies to Criteria 1.2.1.6, 1.2.1.12, 1.2.1.13, 1.2.1.15, 1.2.2.1.3, 1.2.2.1.4, and 1.2.4.5 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.2 Contact Stiffness between Waste Package and Impact Surface

The assumption is made that the contact stiffness value between the waste package and the impact surface can be determined iteratively. This assumption applies to Criterion 1.2.2.1.3 (reference "Waste Package Design Methodology Report," Section 5.2.1.1).

2.2.2.3 Poisson's Ratio of Materials

The Poisson's ratio of Alloy 22 was not available in literature. Therefore, the Poisson's Ratio of Alloy 625 is assumed for Alloy 22. This assumption applies to Criteria 1.2.1.6, 1.2.1.12, 1.2.1.13, 1.2.1.15, 1.2.2.1.3, 1.2.2.1.4, and 1.2.4.5.

The Poisson's ratio of 316L SS was not available in literature. Therefore, the Poisson's ratio of 316 SS is used. This assumption applies to Criteria 1.2.1.6, 1.2.2.1.3, and 1.2.2.1.10 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.4 Solid Connection Between the Inner and Outer Shells

The inner and outer shells are assumed to have solid connections at the adjacent surfaces. This assumption applies to Criteria 1.2.1.6, 1.2.1.12, 1.2.1.13, 1.2.1.15, 1.2.2.1.3, and 1.2.4.5 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.5 Rate Dependent Material Properties

Material properties obtained under the static loading conditions were assumed for all materials. Some of the rate-dependent material properties were not available for the materials used. This assumption applies to Criteria 1.2.2.1.3, 1.2.2.1.4, 1.2.2.1.5, and 1.2.2.1.6 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.6 Large Elastic Modulus Used for the Unyielding Surface

The target surface is conservatively assumed to be essentially unyielding by using a large elastic modulus (1×10^{13} N/m^2) for the target surface compared to the waste package. This assumption applies to Criteria 1.2.2.1.3, 1.2.2.1.4, 1.2.2.1.5, and 1.2.2.1.6 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.7 Uniform Mass Density for Naval SNF Canister

The exact geometry of the naval SNF canister is simplified such that its total mass, 44,452 kg, is distributed within the cylinder of circular cross section and uniform mass density. This assumption slightly increases the bending moment acting on the weld joining the lower inner shell lid and the inner shell. This assumption applies to Criterion 1.2.2.1.3 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.8 Geometry of the Outer Shell

The exact geometry of the extension of the outer shell (e.g., skirt) is simplified such that the total mass of the outer shell, 9,659 kg, is distributed within the cylindrical shell of constant wall thickness. Since the values of the inner and outer shell diameters, essential for the calculation results, must be kept intact, the skirt length is increased to accommodate the outer shell mass. This assumption applies to Criteria 1.2.1.12, 1.2.1.13, and 1.2.1.21 (reference "Waste Package Design Methodology Report," Section 5.2.1.2).

2.2.2.9 Assumption of Waste Package Shell as Flat Plate for Impact Analysis

Empirical relations of flat plates are assumed to be applicable to determining the structural response of the waste package shells to missile impact load. This assumption applies to Criteria 1.2.2.1.1, 1.2.2.1.2, and 1.2.2.1.8 (reference "Waste Package Design Methodology Report," Section 5.2.4.2).

2.2.2.10 Boundary Conditions for Impact Analyses

The fixed-end boundary conditions assumed for the waste package shells in the localized region of missile impact are described in "Waste Package Design Methodology Report," Section 5.2.4.3. This assumption applies to Criteria 1.2.2.1.1, 1.2.2.1.2, and 1.2.2.1.8 (reference "Waste Package Design Methodology Report," Section 5.2.4.3).

2.2.2.11 Application of Empirical Relationships for Impact Analyses

Empirical relations are used to determine an approximate behavior of the disposal container shells impacted by a pressurized system missile. These relations are assumed to give conservative results for the waste package shells. The literature of dynamic impact analyses shows that various empirical equations were developed for the perforation of ductile metal plates; specifically, mild steel (low-carbon steel) plates. This assumption applies to Criteria 1.2.2.1.1, 1.2.2.1.2, and 1.2.2.1.8 (reference "Waste Package Design Methodology Report," Section 5.2.4.1).

2.2.2.12 Lid Failure

The inner lid is assumed to fail before the outer lid; no structural credit is taken for the outer lid. This assumption applies to Criterion 1.2.2.1.10 (reference "Waste Package Design Methodology Report," Section 5.2.3).

2.2.2.13 Analysis of a 21-PWR WP Assumed to Bound the Naval SNF WP

The internal pressure of the 21-PWR waste package is assumed for the naval SNF long disposal container design. This assumption applies to Criterion 1.2.2.1.10 (reference "Design Analysis for the Naval SNF Waste Package," Section 5).

2.2.2.14 Cracks Formed During Design Basis Events

Only one crack is assumed to develop in the waste package outer shell due to design basis events (DBEs). This assumption applies to Criteria 1.2.2.1.8 and 1.2.2.1.10 (reference "Waste Package Design Methodology Report," Section 5.2.2).

2.2.2.15 **Omission of Structural Damping**

No structural damping is used for the material in the evaluation. Attenuation of stress waves is not of interest, because the failure criteria is based only on the comparison of maximum stress with the ultimate tensile strength. This assumption applies to Criteria 1.2.2.1.3, 1.2.2.1.4, 1.2.2.1.5, and 1.2.2.1.6 (reference "Waste Package Design Methodology Report," Section 5.2.6.4).

2.2.3 **Thermal**

2.2.3.1 **2-Dimensional Finite Element Representation**

It is assumed that a 2-dimensional finite element representation of the disposal container cross section midway along the axis will conservatively represent the disposal container. Inherent to this assumption is that axial heat transfer does not significantly affect the solution (i.e., the flow of heat in the radial direction is assumed to dominate the solution). This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.3.1).

2.2.3.2 **Conduction and Radiation Heat Transfer**

The thermal analysis of the naval SNF waste package assumes only conduction and radiation heat transfer internal to the waste package. Convective heat transfer is not included in the thermal analysis. The model is expected to result in a slightly higher peak temperature for the components internal to the naval SNF waste package. This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.3.2).

2.2.3.3 **Properties of Helium**

The properties of helium at a pressure of one atmosphere are assumed to be representative of the conditions that it will experience in the disposal container. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.1).

2.2.3.4 **Volumetric Heat Generation Rate of the Naval Canister**

The volumetric heat generation rate of the naval SNF canister is assumed homogenous over the cross section considered for the calculation. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.7).

2.2.3.5 **Waste Package Cross Section**

To determine the heat rejection flux, it is assumed that the waste package can be represented by half the waste package cross section. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.2).

2.2.3.6 Decay Heat Output of the Naval Canister

The design basis decay heat output is assumed for the naval SNF and the decay heat output for naval SNF is assumed to remain constant at the 250-year design basis decay heat output value for periods beyond 250 years. Using the design basis heat output results in a higher predicted peak temperature for the components internal to the naval SNF waste package. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.3).

2.2.3.7 Canister Location Within a Waste Package

The naval SNF canister is assumed centered within the waste package. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.4).

2.2.3.8 Emissivity of Stainless Steel

The emissivity of stainless steel 316L is assumed to be 0.60. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.5).

2.2.3.9 Boundary Temperature History for Naval Canisters

The boundary temperature history for the naval SNF long waste package surface temperature is assumed to be bounded by the boundary temperature history for the design basis 21-PWR waste package. This assumption applies to Criterion 1.2.1.4 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.3.1.6).

2.2.3.10 Location of Repository Horizon

The repository horizon is assumed to be located in the Topopah Spring welded, lithophysae-poor geologic unit (TSw2). This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.1.1).

2.2.3.11 Pillar Representation of Repository

It is assumed the potential repository is a rectangular parallelepiped. This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.1.2).

2.2.3.12 Omission of Gross Water Movement

The effect of water mobilization into the repository from the surrounding rock matrix, as well as that from percolation flux that reaches the repository horizon from the surface, is neglected. Excluding water mobilization and percolation flux is expected to result in a higher predicted peak temperature for the components internal to the naval SNF waste package. This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.1.3).

2.2.3.13 Fixed Temperature at the Surface of the Mountain

The boundary condition at the top of both two- and three-dimensional repository representations is a fixed temperature. This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.1.5).

2.2.3.14 Initial Temperature Gradient in the Mountain

The initial thermal gradient in the host rock is assumed to be that shown in Table 4. This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.1.6).

Table 4. Initial Temperature Gradient in Host Rock

Depth Range (m)	Gradient (°C/m)
0-150	0.020
150-400	0.018
400-1300	0.030

2.2.3.15 Modes of Heat Transfer within the Drift

Within the drift and the near-field rock, during the repository postclosure period, heat transfer is represented by radiation and conduction only. Convective heat transfer is neglected. This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.2.1).

2.2.3.16 Approximation of Heat-Removal by Ventilation

Forced-convection heat transfer is not explicitly represented in the drift; rather, a reduction in heat generation is used as a proxy for this mode of heat transfer (i.e., the ventilation efficiency). This assumption applies to Criterion 1.2.1.4 (reference "Waste Package Design Methodology Report," Section 5.3.2.2).

2.2.4 Shielding

2.2.4.1 Material Properties for SS 316NG

SS 316L is assumed instead of SS 316NG for the inner shell of the waste package. This assumption applies to Criterion 1.2.4.1 (reference "Design Analysis for the Naval SNF Waste Package," Section 5.4.1.1).

2.2.4.2 Weight Percent

For elements (those described in a Periodic Table of the Elements) with ranges of weight percent of material compositions, the midpoint value is used, and the weight percent of the most abundant element is adjusted. This assumption applies to Criterion 1.2.4.1 (reference "Waste Package Design Methodology Report," Section 5.4.7).

2.3 DETAILED DESIGN DESCRIPTION

The naval SNF long disposal container design will be the limiting design because it is greater in size and weight than the naval SNF short disposal container. The naval SNF long disposal container consists of two right-circular cylinders, hereafter called shells. It is comprised of two shells, an inner shell of stainless steel that provides structural support and an outer shell of high-nickel alloy that provides a corrosion-resistant barrier. The inner structural shell is inserted inside the outer corrosion-resistant shell. There are two lower lids that are welded to the shells at the time of fabrication. There are three upper lids that are welded in place after the disposal containers are loaded with the appropriate waste forms (reference "Design Analysis for the Naval SNF Waste Package," Section 6). Figures 1 and 2 provide views of the overall disposal container arrangement and the upper lids closure welds, respectively.

No baskets, plates, thermal shunts, or fuel tubes are used in the naval SNF disposal container design. The cavity of the naval SNF long disposal container is 5,415 mm long and has an inner diameter of 1,719 mm. Additional naval SNF long disposal container properties and spent fuel canister characteristics are shown in Tables 5 and 6, respectively (reference "Design Analysis for the Naval SNF Waste Package," Attachment II, SK-0194).

Table 5. Naval SNF Long Disposal Container Dimensions

Outer Diameter (m)	1.869
Outer Length (m)	6.065
Empty Mass (kg)	28,005
Loaded Mass (kg)	72,457

(Reference "Design Analysis for the Naval SNF Waste Package," Attachment II, SK-0194)

Table 6. Naval SNF Fuel Canister Characteristics

Characteristic	Naval SNF (Long)
Canister Maximum Outer Diameter (Note 1)	1,679.4 mm (66.12 in.)
Canister Maximum External Length (Note 1)	5,350 mm (210.63 in.)
Canister Maximum Weight (Note 2)	44,452 kg (49.0 tons)
Maximum Canister Design Basis Heat Source at the Time of Emplacement (Note 3)	8.01 kW
Emissivity of Canister (Note 3)	0.6
Average Lumped Thermal Conductivity (Notes 3 4)	3.3 W/m-k
Average MTU/Canister (Note 3)	0.22

Note 1: Reference "Waste Acceptance System Requirements Document," p.36

Note 2: Reference "Design Analysis for the Naval SNF Waste Package," p. 16 Table 4 (Conversion factor of 907.1847)

Note 3: Reference "Design Analysis for the Naval SNF Waste Package," p. 16 Table 3

Note 4: Average Lumped Thermal Conductivity for the naval SNF Short Fuel Canister is 3.7 W/m-k (Reference "Design Analysis for the Naval SNF Waste Package," Table 3)

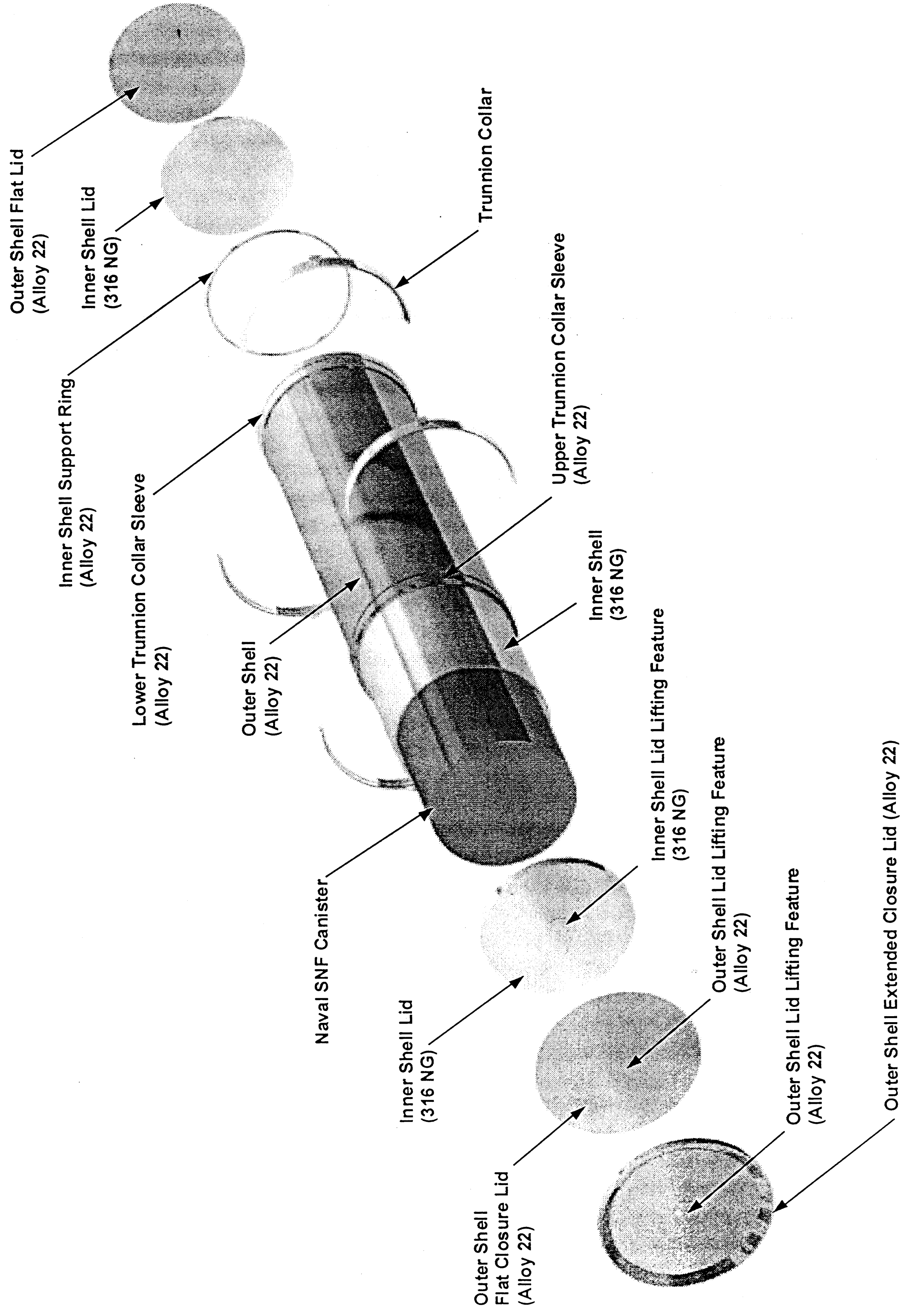

Figure 1. Naval SNF Long Disposal Container Configuration

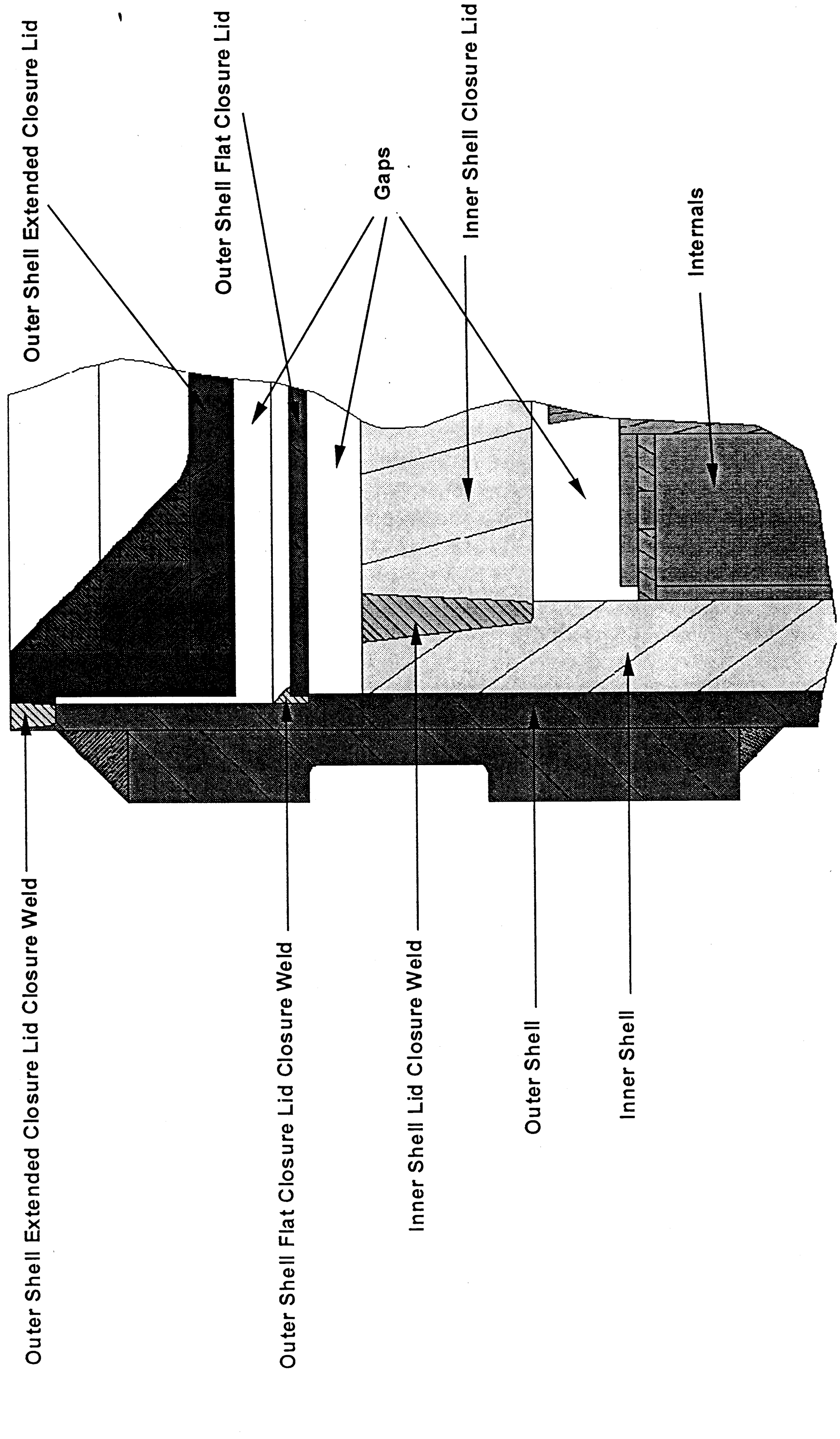

Figure 2. Closure Welds Configuration

2.4 COMPONENT DESCRIPTION

2.4.1 Lids

The disposal container lid configuration consists of three lids on the top of the disposal container and two lids on the bottom of the disposal container. Lid materials and dimensions are provided in Table 7.

Table 7. Naval SNF Long Disposal Container Lids

Lid	Material	Thickness
Extended Outer Shell Lid (Top)	SB-575 N06022	25 mm
Outer Shell Flat Closure Lid (Top)	SB-575 N06022	10 mm
Inner Lid (Top)	SA-240 S31600	130 mm
Inner Lid (Bottom)	SA-240 S31600	130 mm
Outer Shell Flat Bottom Lid (Bottom)	SB-575 N06022	25 mm

(Reference "Design Analysis for the Naval SNF Waste Package," Attachment II, SK-0194)

2.4.2 Lifting Features

The disposal containers are designed to accept trunnion rings (see Figure 3). The use of trunnion rings permits attachment of fixtures that may be used for both vertical and horizontal handling of the waste package, as well as handling attitudes between vertical and horizontal. These trunnion rings are removed after the waste package is placed on the emplacement pallet; therefore, the use of trunnion rings does not create a site for cracking due to crevice corrosion. Further, trunnion rings are attached to a corresponding built-up area on the waste package (known as collar sleeves) and will not induce stresses that might exacerbate corrosion of the outer barrier. Materials of construction and dimensions for the collar sleeves are provided in Table 8.

Table 8. Naval SNF Long Disposal Container Collar Sleeves

Component Name	Material	Thickness	Length
Upper Trunnion Collar Sleeve	SB-575 N06022	40 mm	340 mm
Lower Trunnion Collar Sleeve	SB-575 N06022	40 mm	345 mm

(Reference "Design Analysis for the Naval SNF Waste Package," Attachment II, SK-0194)

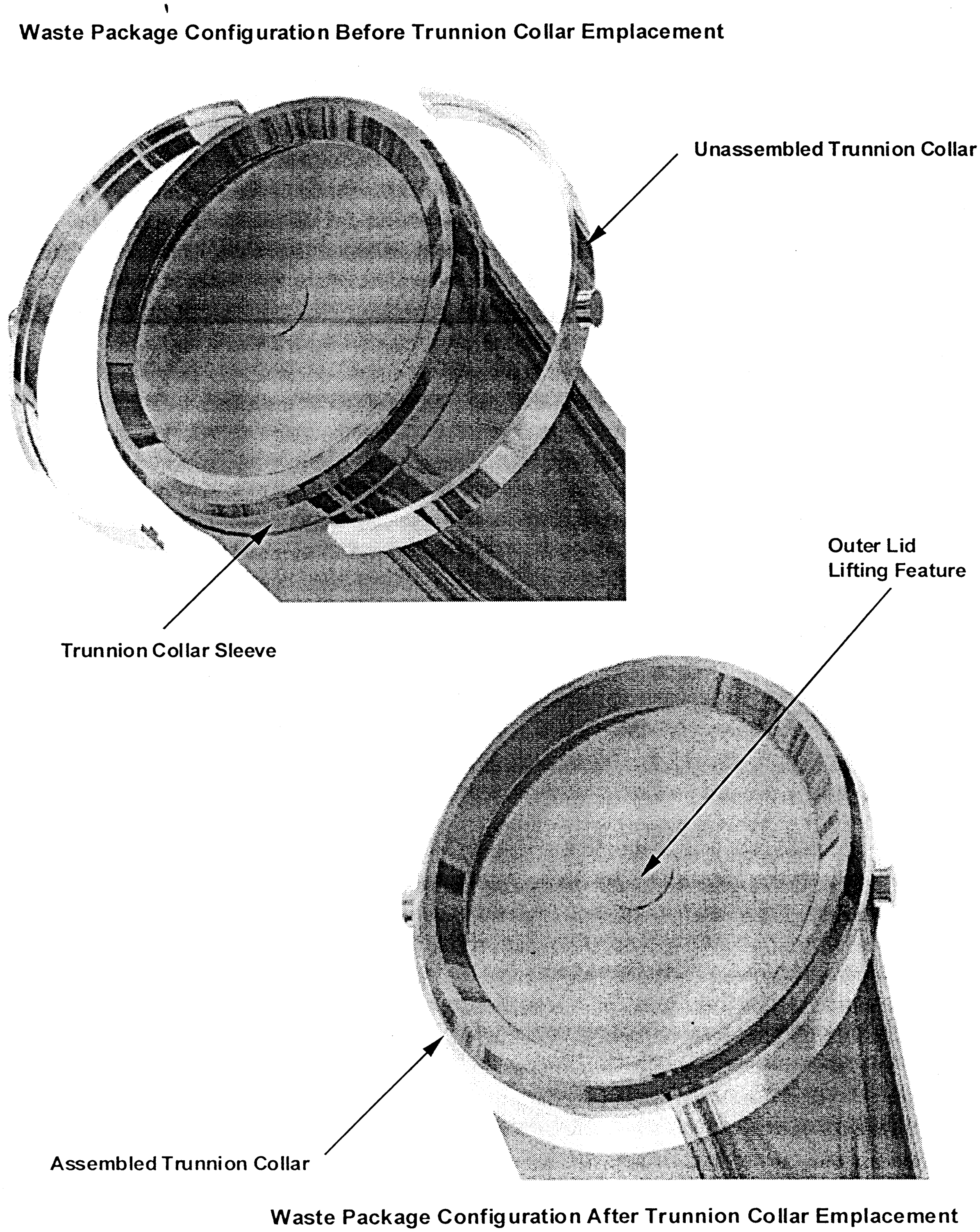

Figure 3. Trunnion Collar Configuration

2.4.3 Fill Gas

Fill gas is used to provide an inert atmosphere within the waste package (between the naval canister and the disposal container) and to facilitate heat conduction from the waste form to the containment barriers. The fill gas can be a significant conductor of heat from the fuel to the basket, so thermal performance was deemed to be one of the most important criteria in choosing a gas. The fill gas should not degrade other components of the waste package, so compatibility with other materials was another important criterion. Based on a review of data on thermal conductivity, and the fact that helium is chemically inert, it was chosen over other candidate gases; such as nitrogen, argon, and krypton (reference "Waste Package Neutron Absorber, Thermal Shunt, and Fill Gas Selection Report," Sections 3.3.1 through 3.3.3). The waste package (between the naval canister and the disposal container) will be filled with helium to approximately one atmosphere of pressure.

2.5 CRITERIA COMPLIANCE

This section contains the demonstration that the Site Recommendation waste package design satisfies the selected SDD criteria. It is limited to SDD criteria that were selected for the naval SNF long waste package design by the "Waste Package Design Sensitivity Report." The remaining SDD criteria are either demonstrated by the other waste package designs and therefore addressed in the DHLW SDD, or the uncanistered fuel (UCF) SDD or will not be demonstrated until License Application (reference "Design Analysis for the Naval SNF Waste Package," Section 6).

2.5.1 System Performance Criteria

2.5.1.1 Limiting Total Effective Dose (Criterion 1.2.1.1)

Satisfaction of this criterion will be demonstrated in a report to be prepared by the Performance Assessment Organization (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.1).

2.5.1.2 Accommodation of Naval SNF Canisters (Criterion 1.2.1.2)

It may be demonstrated by inspection of the sketch contained in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) that naval SNF canisters that are 5.350 m (210.63 in.) or shorter in length can be accommodated (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.3).

2.5.1.3 Thickness and Composition of Cylinders (Criterion 1.2.1.3)

Due to the SDD criterion for preclosure rock fall, an outer cylinder thickness of 25 mm has been specified by the design engineers. The 25-mm thickness exceeds the 20-mm SDD criterion. The material callout on the sketches in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) specifies the use of

SB-575 N06022 for the outer shell, which is the ASME material designation for Alloy 22.

The SDD specifies the inner cylinder be constructed of approximately 50-mm thick 316L stainless steel. The material callout on the sketches in "Design Analysis for the Naval SNF Waste Package" (Attachment II) specifies the use of SA-240 S31600, which is equivalent to American Society for Testing and Materials (ASTM) SS 316 NG (reference "Design Analysis for the Naval SNF Waste Packages," Section 6).

2.5.1.4 Waste Package Minimum Heat Rejection Flux (Criterion 1.2.1.4)

Performance of the waste package is shown in "Thermal Evaluation for the Naval SNF Waste Package" (reference "Design Analysis for the Naval SNF Waste Packages," Section 6.3.1.4). This criterion is satisfied for the range of maximum allowable heat fluxes provided by the Naval Nuclear Propulsion Program. The range for maximum allowable heat fluxes will be expanded and evaluated for compliance prior to Site Recommendation.

2.5.1.5 Prevent Breach During Normal Handling Operations (Criterion 1.2.1.5)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Packages," Table 7).

2.5.1.6 Retrieval Contingency Period (Criterion 1.2.1.6)

The waste package must be designed to allow retrieval up to 300 years after emplacement. The naval long SNF waste package is the heaviest waste package for the purposes of retrieval. The ability of the waste package and pallet to be lifted together as a single unit was calculated. The results show that the maximum stress intensities among the emplacement pallet Alloy 22 and 316L SS components are 96 MPa and 39 MPa, respectively. These stress intensity magnitudes are less than one-third of the yield strength and one-fifth of the tensile strength for each of the corresponding materials.

Atmospheric corrosion penetration rates for Alloy 22 and 316L SS are 0.0093 μm/yr and 0.025 μm/yr, respectively. Therefore, the expected cumulative decrease of thickness of the structural members of the emplacement pallet over 300 years of preclosure emplacement is 2.8 μm for Alloy 22, and 7.5 μm for 316L SS. This negligible level of corrosion renders the waste package retrieval calculation unnecessary, since the consequential change of the results presented in this calculation would be insignificant (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.5).

2.5.1.7 External Surface Finish (Criterion 1.2.1.7)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.1.8 Inspectability of Waste Packages (Criterion 1.2.1.8)

It may be demonstrated by inspection of the sketches in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) that all surfaces are accessible for visual inspection and decontamination (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.6).

2.5.1.9 Unique Label/Identification (Criterion 1.2.1.9)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.1.10 Label Does Not Impair Integrity (Criterion 1.2.1.10)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.1.11 Labels Legible (Criterion 1.2.1.11)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.1.12 Capacity of Lifting Devices – Tensile Yield Strength (Criterion 1.2.1.12)

The naval SNF waste package is lifted using attachable trunnion rings that lock into grooves called collar sleeves. The applicable criterion is for the tensile yield strength of the material to be at least three times the maximum expected lifting stress. The structural response of the waste package to lifting is reported using maximum stress values obtained from the finite element solution to the problem. Compliance is demonstrated in that the tensile yield strength of Alloy 22 (310 MPa) is more than three times larger than the maximum expected stress (15.595 MPa) (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.7).

2.5.1.13 Capacity of Lifting Devices – Ultimate Tensile Strength (Criterion 1.2.1.13)

The naval SNF waste package is lifted using attachable trunnion rings that lock into grooves on the collar sleeves. The applicable criterion is for the ultimate tensile strength of the material to be at least five times the maximum expected lifting stress. The structural response of the waste package to lifting is reported using the maximum stress values obtained from the finite element solution to the problem. Compliance is demonstrated by showing that the ultimate tensile strength of Alloy 22 (690 MPa) is more than five times larger than the maximum expected stress (15.595 MPa) (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.8).

2.5.1.14 Reserved

2.5.1.15 Withstand Subsurface Facility Handling Environments (Criterion 1.2.1.15)

This design criterion is demonstrated through the tensile yield strength and ultimate tensile strength of the lifting devices presented in Sections 2.5.1.12 and 2.5.1.13 (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.8).

2.5.1.16 Reserved

2.5.1.17 Use of Non-combustible and Heat Resistant Materials (Criterion 1.2.1.17)

It may be demonstrated by inspection of the sketch in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) that the material call-outs for all components of the waste package are metallic and, hence, non-combustible. Similarly, the metals selected, which are not necessarily refractory, are resistant to heat. In addition, the naval canister and its internal components must conform to the "Waste Acceptance System Requirements Document" (Section 4.2.2) which precludes the use of these materials (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.10).

2.5.1.18 Exclusion of Explosive or Pyrophoric Materials (Criterion 1.2.1.18)

It may be demonstrated by inspection of the sketch in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) that the material call-outs for all components of the waste package exclude explosive and pyrophoric materials. In addition, the naval canister and its internal components must conform to the "Waste Acceptance System Requirements Document" (Section 4.2.2) which precludes the use of these materials (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.11).

2.5.1.19 Exclusion of Free Liquids (Criterion 1.2.1.19)

It may be demonstrated by inspection of the sketch in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) that the material call-outs for all components of the waste package exclude the use of free liquids. In addition, the naval canister and its internal components must conform to the "Waste Acceptance System Requirements Document" (Section 4.2.2) which precludes the use of these materials (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.1.12).

2.5.1.20 Manufacturing Residual Tensile Stresses of the Outer Barrier (Criterion 1.2.1.20)

Manufacturing tensile stresses are highest in the weld region of the disposal container. Those welds are solution annealed to remove stress. Residual tensile stresses in the closure welds were examined in the calculation entitled "Residual Stress Minimization of Waste Packages from Induction Annealing." The calculation looked at five different weld designs to determine which offered the best induction annealing stress relief. Design #5 outperformed the others with a calculated residual stress field after the annealing process that was 5.8 mm in depth. As a result, design #5 has been chosen as the closure design for the naval SNF waste package. The calculation demonstrates the method that will be used to show compliance with Criterion 1.2.1.20.

2.5.1.21 Static Loads in the Outer Barrier at the Interface with the Emplacement Pallet (Criterion 1.2.1.21)

The calculation "Tensile Stresses Developing in an Outer Shell of a Waste Package Mounted on an Emplacement Pallet" demonstrates that the maximum stress intensities in the waste package outer barrier Alloy 22 is 17 MPa. This stress intensity is less than 10 percent of the yield strength of Alloy 22. The criterion is satisfied.

2.5.1.22 Stresses in the Outer Barrier during a Seismic Event (Criterion 1.2.1.22)

A calculation is in progress to demonstrate compliance of a preclosure seismic event. Postclosure seismic events will not be demonstrated for Site Recommendation.

2.5.2 Safety Criteria

2.5.2.1 Preclosure Rock Fall Without Breach (Criterion 1.2.2.1.1)

The 21 PWR design is the representative waste package for preclosure rockfall. It was chosen for its thinner wall thickness in the outer barrier Alloy 22 (20 mm vs. 25 mm) and its greater sensitivity to internal basket deformation. It is also the most common package and, hence, the most likely to suffer a rock fall event. Therefore, the SDD prepared for uncanistered SNF addresses this criterion rather than this document (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.1).

2.5.2.2 Preclosure Impact on the End of the Waste Package Without Breach (Criterion 1.2.2.1.2)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.2.3 Preclosure Vertical Drop Without Breach (Criterion 1.2.2.1.3)

Calculated results indicate that the maximum stress intensities among the waste package Alloy 22, except for the lower trunnion collar sleeve, and 316NG SS components are 433 MPa and 275 MPa, respectively. These stress intensities are less than nine-tenths of the tensile strength for each of the corresponding materials, hence, compliance is demonstrated. The maximum stress intensity in the lower trunnion collar sleeve in the region of contact with the unyielding surface is 799 MPa, which exceeds the tensile strength of Alloy 22. However, the lower trunnion collar sleeve acts as a crush zone for the waste package at the point of impact and is not a part of the fuel containment (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.3).

2.5.2.4 Preclosure Horizontal Drop Without Breach (Criterion 1.2.2.1.4)

The survivability of a naval SNF waste package to a horizontal drop has been demonstrated in a calculation entitled "Horizontal Drop of the Naval SNF Long Waste Package on Unyielding Surface." The results show that the maximum stress intensities occur in the lower trunnion collar with a level of 798 MPa, which exceeds the tensile strength of Alloy 22. However, the lower trunnion collar sleeve is not part of the containment barrier. It acts as an impact-limiter (crush zone) for the containment barrier in this case.

The maximum stress intensity on the outer surface of the outer shell has a level of 694 MPa, which exceeds the tensile strength of Alloy 22. However, a closer examination of the region in which this level of intensity occurs, shows the stress decreases significantly along the thickness of the shell. Thus, the maximum stress intensity on the inner surface of the outer shell has a maximum level of 580 MPa. This is less than nine-tenths of the tensile strength of Alloy 22. Hence, a breach of the outer shell is not anticipated.

The maximum stress intensity in the inner shell is 484 MPa. Again, closer examination of the region in which this level of intensity occurs, shows the stress decreases significantly along the thickness of the shell. Thus, the maximum stress intensity on the inner surface of the inner shell has a maximum level of 430 MPa. This is less than nine-tenths of the tensile strength of 316 NG SS. Hence, a breach of the inner shell is not anticipated and compliance is demonstrated (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.4).

2.5.2.5 Preclosure Horizontal Drop onto a Steel Support or Concrete Pier (Criterion 1.2.2.1.5)

The 44-BWR waste package was chosen as the representative waste package for a preclosure horizontal drop with the emplacement pallet onto an unyielding surface. A drop of the pallet/waste package combination would allow the pallet to act as a crush zone or impact limiter for the waste package. Pallet puncture of the waste package is of greater concern than is in-drift structure. A calculation entitled "Puncture Drop of the 44-BWR Waste Package" describes the method and results for the 44-BWR waste package. It was chosen for its thinner wall thickness in the outer shell Alloy 22 (20 mm vs. 25 mm) and its greater sensitivity to internal basket deformation. The method used to evaluate the 44-BWR will be used to evaluate the naval SNF waste package for compliance (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.2).

2.5.2.6 Preclosure Tip Over and Slap Down Without Breach (Criterion 1.2.2.1.6)

The 21-PWR waste package is the representative waste package for the preclosure tip over and slap down evaluation. It was chosen for its thinner wall thickness in the outer barrier Alloy 22 (20 mm vs. 25 mm) and its greater sensitivity to internal basket deformation. It is also the most common package and, hence, the most likely to suffer a tip over and slap down design basis event. Therefore, the 21-PWR rather than the naval SNF waste package will be evaluated for SR. The methodology used to evaluate that package will be identical to the methodology that will be used to evaluate the naval SNF waste package for License Application (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.5).

2.5.2.7 Withstand a Preclosure Design Basis Earthquake (Criterion 1.2.2.1.7)

Compliance with this criterion will not be demonstrated for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.6).

2.5.2.8 Sustain Preclosure Missile Impact Without Breach (Criterion 1.2.2.1.8)

It has been demonstrated that the naval SNF long design can withstand the impact of a 0.5 kg missile (1 cm diameter) travelling at 5.7 m/sec. The calculated minimum velocity required to perforate the shell, as a result of such an impact, is 339 m/sec. Compliance with this criterion is demonstrated by an empirical comparison. A missile with a velocity of 5.7 m/sec has 1.7 percent of the necessary impact velocity to compromise the waste package integrity (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.7).

2.5.2.9 Transporter Runaway (Criterion 1.2.2.1.9)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.2.10 Sustain Maximum Internal Pressure Limit (Criterion 1.2.2.1.10)

The survivability of a naval SNF waste package due to an internal pressurization event has been demonstrated in a calculation entitled "Internal Pressurization Due to Fuel Rod Rupture in Waste Packages." A correlation has been made from calculations performed for the 21-PWR waste package in which all rods within the waste package are assumed to rupture at once.

The internal pressure for the naval SNF waste package was calculated using the thermodynamic equation of state for constant density, and knowledge of the void space between the naval canister and the naval waste package. The calculation determined the membrane and bending stress, over a range of temperatures, extant on the closure weld of the inner shell of the naval SNF waste package. The inner lid closure weld is considered the weakest point on the inner shell. No credit has been given for the outer shell or lids. At 600 degrees C the membrane plus bending stress equals 202 MPa and is below nine-tenths of the yield strength for 316 NG SS. This criterion is TBD and therefore, compliance can not be demonstrated until the TBD is resolved (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.8). The Naval Nuclear Propulsion Program will provide a bounding value for the internal pressurization of naval SNF waste packages prior to License Application.

2.5.2.11 Hypothetical Fire (Criterion 1.2.2.1.11)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.2.12 Preclosure Criticality (Criterion 1.2.2.1.12)

The U.S. Navy's Naval Reactors Program will assess the criticality performance of naval SNF (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.2.9).

2.5.2.13 Postclosure Criticality (Criterion 1.2.2.1.13)

Criticality analyses for naval SNF waste packages will be performed in accordance with "Transmittal of the Naval Nuclear Propulsion Program addendum to the Yucca Mountain Site Characterization Office 'Disposal Criticality Analysis Methodology Topical Report,'" and accordingly are in compliance with this criterion.

2.5.3 System Environment Criteria

2.5.3.1 Emplacement Drift Environment (Criterion 1.2.3.1)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.4 System Interfacing Criteria

2.5.4.1 Limitation of Waste Package Surface Radiation Dose Rate (Criterion 1.2.4.1)

The second-level confidence interval for the estimate of the maximum dose rates on the external surfaces of the naval SNF waste package is 412 ± 1 rem/hr. Criterion 1.2.4.1 specifies the maximum dose rate as TBD, therefore, compliance cannot be measured. The calculated surface radiation dose rate for naval SNF is less than the calculated surface dose rate for the 44-BWR waste package; accordingly, it is expected the naval SNF waste package will be able to comply with this requirement (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.3.1).

2.5.4.2 Maximum Thermal Output of Waste Package (Criterion 1.2.4.2)

The design basis heat-generation rate for the naval SNF canister is 8.01 kW, and therefore, well below the 11.8 kW limit and in compliance with this criterion (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.3.2).

2.5.4.3 Limitation on the Quantity of the Waste Form (Criterion 1.2.4.3)

There are 300 naval canisters, totaling no more than 65 MTHM, scheduled for emplacement within the repository. This quantity is in compliance with the 65 MTHM limit imposed (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.3.3).

2.5.4.4 Vertical Loading and Sealing of Waste Packages (Criterion 1.2.4.4)

It may be demonstrated by inspection of the sketch in the "Design Analysis for the Naval SNF Waste Package" (Attachment II) that the waste package may be loaded in a vertical attitude (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.3.4).

2.5.4.5 Allow Horizontal and Vertical Handling of the Waste Package (Criterion 1.2.4.5)

As may be seen by reviewing the sketch in the "Design Analysis for the Naval SNF Waste Package" (Attachment I) that the waste package is designed to accept trunnion rings. The use of such rings permits attachments of fixtures that may be used for both vertical and horizontal handling of the waste package, as well as handling attitudes between vertical and horizontal.

These trunnion rings are removed after the waste package is placed on the emplacement pallet; therefore, the use of such rings does not create a site for cracking due to crevice corrosion. Further, the trunnion rings are attached to a corresponding built-up area on the waste package and will not induce stresses that might exacerbate corrosion of the outer barrier (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.3.5).

2.5.4.6 Welding Times (Criterion 1.2.4.6)

This design criterion will not be addressed for Site Recommendation (reference "Design Analysis for the Naval SNF Waste Package," Table 7).

2.5.4.7 Interface Control Document for Mechanical and Envelope Interfaces (Criterion 1.2.4.7)

This design criterion will not be addressed for Site Recommendation.

2.5.5 Codes and Standards Criteria

2.5.5.1 "1995 ASME Boiler and Pressure Vessel Code" (Section III, Div. 1, Subsection NG-1995) (Criterion 1.2.6.1)

There are no codes or standards that apply directly to the design of disposal containers; however, the "1995 ASME Boiler and Pressure Vessel Code" has been chosen as a guide for setting stress limits for the waste package components. Applications of subsections of Section III of the 1995 ASME code are shown in Table 9 (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.4.1).

Table 9. Applicability of 1995 ASME Boiler and Pressure Vessel Code

Analysis Type	Component	Section III, Subsection Applied	Service Limits*
Static	Barriers	Subsection NB	Level A
	Basket	Subsection NG	Level A
Seismic	Barriers	Subsection NB, Appendix F	Level D
	Basket	Subsection NG, Appendix F	Level D
Rock Fall	Barriers	Subsection NB, Appendix F	Level D

* Level A Service Limits are for normal operation. Level D Service Limits are for off-normal conditions.

As may be seen from Table 9, Subsection NG is used for operations consistent with normal activities with the Level A Service Limits. From the code, the limitation on membrane and bending stresses at Level A are:

$$P_m + P_b = 1.5 \cdot S_m$$

Here, P_m is the membrane stress, P_b is the bending stress, and S_m is the design stress for the material. For design purposes, the design stress is assumed to be two-thirds of the yield stress; therefore, the allowable total stress (including both membrane and bending) is equal to the yield stress (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.4.1).

2.5.5.2 "1995 ASME Boiler and Pressure Vessel Code" (Section III, Div. 1, Sub-section NB-1995) (Criterion 1.2.6.2)

For Level D Service Limits, Sub-section NB of the "1995 ASME Boiler and Pressure Vessel Code" are used, as shown in Table 9. From the code, the limitation on membrane and bending stresses at Level D are:

$$P_m + P_b < 0.9 \cdot S_u$$

Here, S_u is the ultimate tensile strength of the material (reference "Design Analysis for the Naval SNF Waste Package," Section 6.3.4.2).

3. SYSTEM OPERATIONS

This section will be completed in a later revision.

4. SYSTEM MAINTENANCE

This section will be completed in a later revision.

APPENDIX A CRITERION BASIS STATEMENTS

This section presents the criterion basis statements for criteria in Section 1.2. Descriptions of the traces to "Monitored Geologic Repository Requirements Document" (MGR RD) and "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada" are shown as applicable. In anticipation of the interim guidance being promulgated as a Code of Federal Regulations, it will be referred to as "10 CFR 63" in this system description document.

1.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the overall level of performance of the repository to which this system will contribute. This criterion supports MGR RD 3.1.C and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The performance parameters are taken from 10 CFR 63.113(b).

1.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This requirement is needed to establish the types of naval SNF canisters that must be considered in design of the naval SNF disposal container. This criterion is supported by MGR RD 3.2.B and 3.2.C.

II. Criterion Performance Parameter Basis

Canister material information is provided in Attachment 2, p. 1 of "Response to Information Request From Jason Technologies on the Total Amount of Radioactivity in Naval Special Case Waste and Supplemental Information on the Chemical Composition of Naval Spent Nuclear Fuel Intended for Disposal in a Geologic Repository," which states that the canister will be constructed primarily of 316L stainless steel.

Supplemental, preliminary information concerning the naval SNF canisters' maximum length, diameter, and loaded weight may be found in "Size and Weight Limits for Canisters Used for Disposal of Naval Spent Nuclear Fuel" (pp. 1 and 2).

1.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C. This criterion is also required for the system to comply with 10 CFR 63.113(a), which requires that the MGR include multiple barriers, including an engineered barrier system. The "Monitored Geologic

Repository Project Description Document" places constraints on the materials of construction and the nominal material thickness of the two concentric cylinders that make up the disposal container. The constraints are intended only to address the corrosion environment. The design must also address other environments (handling, seismic conditions) and if needed, consider additional thickness.

II. Criterion Performance Parameter Basis

The material and nominal thickness parameters are obtained from the "Monitored Geologic Repository Project Description Document" (Section 5.2.12)

1.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C. This requirement is also needed to ensure the expected annual dose to the critical group during the first 10,000 years after permanent closure does not exceed 25 mrem, as required by 10 CFR 63.113(b). This requirement is intended for protection of the naval spent nuclear fuel to assist in the prevention of release of radionuclides (waste isolation).

II. Criterion Performance Parameter Basis

Heat flux parameters are taken from Table 6 of "Thermal, Shielding, and Structural Information on the Naval Spent Nuclear Fuel (SNF) Canister." The maximum allowable heat flux is a function of the canister surface temperature and will be provided by the Naval Nuclear Propulsion Program.

1.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C. This requirement is a consideration of 10 CFR 63.111(a)(2) to protect against radiation exposure and release of radioactive materials during normal handling operations. Also, this criterion is provided to protect the cladding of naval spent nuclear fuel as a barrier to radionuclide release in consideration of 10 CFR 63.113(b).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

N/A

1.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C, 3.1.G, and 3.2.H. This requirement contributes to the ability to retrieve waste packages as required by 10 CFR 63.111(e)(1). This requirement dictates a time period in which the disposal containers must be capable of being moved after emplacement.

This criterion is supported by Guidance Statements 6.12g1 and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The 300-year time period is taken from MGR RD 3.2.H, which requires that the MGR support a deferral of closure for up to 300 years.

1.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C. This requirement supports the decontamination of the disposal container/waste package. By limiting surface roughness of the disposal container the decontamination process will not be impeded. This requirement is derived from the "Mined Geologic Disposal System Functional Analysis Document," function 1.4.3.2.2.4.5, and "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)" (ANSI/ANS-57.9-1992, section 6.2.2.1.2(5).

Limiting surface roughness may also reduce the time required to perform work, particularly decontamination activities, in the vicinity of radioactive materials, which is required by 10 CFR 63.112(e)(2).

II. Criterion Performance Parameter Basis

A published reference for the recommended surface finish of tools, equipment, casks, containers etc., which may become radioactively contaminated does not exist; therefore, the following rule of thumb based on both Commercial Nuclear and Nuclear Navy experience will be used as the basis for selecting the surface finishes. (Note that the highest number has the roughest finish.)

250 μin: Use in applications where the item is not expected/designed to become radioactively contaminated. However, if exposed to radioactive contamination, this finish can still be decontaminated.

125 μin: Use in applications where the item is expected to be exposed to high levels of radioactive contamination during normal operations and which will require

periodic decontamination to minimize personnel exposure and prevent the spread of contamination (e.g., cask wet pit operations).

63 µin: Use in applications where the item is expected to be routinely exposed to high levels of radioactive contamination during normal operations and which will require periodic decontamination to minimize personnel exposure and prevent the spread of contamination (e.g., servicing tools and fuel handling tools).

The 250 µin value is selected for the disposal container because the container is not expected to become contaminated due to waste handling operations. In addition, the postclosure performance of one finish over another is not a distinguishing factor for long term performance in the models used for Total System Performance Assessment (TSPA) analyses.

1.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This requirement guides disposal container design away from a design that would be difficult to decontaminate by precluding undesirable external geometries (e.g., blind holes). Disposal containers for spent nuclear fuel received and loaded in canisters, such as naval spent nuclear fuel, should not under normal operating conditions require decontamination because the radionuclides in the fuel will be completely contained within the canisters. However, in consideration of off-normal and design basis events, the capability for decontamination is to be provided.

This requirement is intended to be assessed against the as-designed disposal container without regard to actual disposal container use, which would preclude surface visibility (e.g., disposal container emplacement on pedestals would preclude visibility of the pedestal to disposal container contact points).

Also, accessibility of the waste package surfaces to visual inspections may reduce the time required to perform work in the vicinity of radioactive materials, which is required by 10 CFR 63.112(e)(2) and MGR RD 3.1.C.

II. Criterion Performance Parameter Basis

N/A

1.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion supports the tracking of all waste packages as required by MGR RD 3.1.C, MGR RD 3.3.K, and 10 CFR 63.78. This criterion also supports the MGR RD 3.1.B requirement to implement the applicable provisions of "Standards for Protection Against Radiation" (10 CFR 20). Also, identification of waste package contents may reduce the time required to perform work in the vicinity of radioactive materials, which is required by 10 CFR 63.112(e)(2).

Waste packages located in surface and subsurface facilities of the MGR are "accessible only to individuals authorized to ...work in the vicinity of the containers..." and are located in storage vaults or hot cells. Therefore, labeling of waste packages is subject to the exemptions provided by 10 CFR 20.1905(e).

II. Criterion Performance Parameter Basis

N/A

1.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C. Label material and method of attachment to the waste package must be considered so that the waste package will not be impaired in its ability to limit the dose rate specified in 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

N/A

1.2.1.11 Criterion Basis Statement

I. Criterion Need Basis

This requirement establishes the length of time that the labels must be legible. This requirement supports MGR RD 3.1.C and is a decomposition of the 10 CFR 63.112(e)(2) in that legibility by remote means may reduce the time required to perform work in the vicinity of radioactive materials. Labels are needed to support the tracking of all waste packages as required by MGR RD 3.3.K and 10 CFR 63.78. This criterion also supports the MGR RD 3.1.D requirement to implement the applicable provisions of "Physical Protection of Plants and Materials" (10 CFR 73), Section 45(d)(1)(iii).

II. Criterion Performance Parameter Basis

N/A

1.2.1.12 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C and 3.1.G. This criterion requires that the disposal container lifting features be designed to withstand handling loads and is needed to reduce the probability of the occurrence of a design basis event in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8).

Reducing the probability of a design basis event may also reduce the time required to perform work in the vicinity of radioactive materials, which is a consideration of 10 CFR 63.112(e)(2).

II. Criterion Performance Parameter Basis

The factors-of-safety are obtained from Section 4.2.1.1 of the "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More" (ANSI N14.6-1993). The scope of ANSI N14.6-1993 encompasses special lifting devices and those features of the attachment members of the containers that affect the function and safety of the lift.

The Yucca Mountain Project may develop (for use in its disposal container designs) different values based on loading conditions that are representative of repository operations. A technical report would provide the supporting technical justification for the project-specific values along with a rationale for not using ANSI N14.6-1993. The stress design factors specified in ANSI N14.6-1993 will be used in the disposal container designs unless project-specific values are required.

1.2.1.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.C and 3.1.G. This criterion requires that the disposal container lifting features be designed to withstand handling loads and is needed to reduce the probability of the occurrence of a design basis event in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8). Reducing the probability of a design basis event may also reduce the time required to perform work in the vicinity of radioactive materials, which is a consideration of 10 CFR 63.112(e)(2).

II. Criterion Performance Parameter Basis

The factors-of-safety are obtained from Section 4.2.1.1 of the "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More" (ANSI N14.6-1993). The scope of ANSI N14.6-1993 encompasses special lifting devices and those features of the attachment members of the containers that affect the function and safety of the lift.

The Yucca Mountain Project may develop (for use in its disposal container designs) different values based on loading conditions that are representative of repository operations, if they are justified. A technical report would provide the supporting technical justification for the project-specific values along with a rationale for not using ANSI N14.6-1993. The stress design factors specified in ANSI N14.6-1993 will be used in the disposal container designs unless project-specific values are required.

1.2.1.15 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C. This criterion is needed for the waste package to comply with 10 CFR 63.111(a)(2), which requires the system perform its intended safety function assuming during normal operations.

This criterion is supported by Guidance Statements 6.12g3 and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

N/A

1.2.1.17 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of thermal loads and fire hazards in support of MGR RD 3.1.C, 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8), which require the disposal container system perform its intended safety function assuming the occurrence of design basis events.

II. Criterion Performance Parameter Basis

N/A

1.2.1.18 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of fire hazards (pyrophoric materials), explosion hazards (explosive materials), and thermal loads (conditions resulting in the ignition of a pyrophoric material and the results of an explosion or fire). This criterion supports MGR RD 3.1.C, 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8), which require the disposal container system perform its intended safety function assuming the occurrence of design basis events.

II. Criterion Performance Parameter Basis

N/A

1.2.1.19 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to support the functions of the waste package to prevent adverse reactions involving the waste form and to provide conditions needed to maintain the physical and chemical stability of the waste form.

II. Criterion Performance Parameter Basis

N/A

1.2.1.20 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure residual stresses do not initiate stress corrosion cracking in the waste package.

II. Criterion Performance Parameter Basis

The stress limit of 10 percent of the outer material yield strength is provided in "Waste Package Degradation Process Model Report," Section 3.1.9.4.

1.2.1.21 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure static loads do not initiate stress corrosion cracking in the waste package.

II. Criterion Performance Parameter Basis

The stress limit of 10 percent of the outer material yield strength is provided in "Waste Package Degradation Process Model Report," Section 3.1.9.4.

1.2.1.22 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure seismic loads do not result in permanent strains that could initiate stress corrosion cracking in the waste package. Maintaining stresses below yield stress ensures that permanent strains are not induced.

II. Criterion Performance Parameter Basis

N/A

1.2.1.23 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required for the system to comply with management direction put into effect via the "Monitored Geologic Repository Project Description Document" (Section 5.2.23).

II. Criterion Performance Parameter Basis

N/A

1.2.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Preclosure Design Basis Events Related to Waste Packages" (Section 7.2.1).

1.2.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.7g1, 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.7g1, 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.7g1, 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The drop height is to be determined.

1.2.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statement 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.1.g1, 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 1) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event, parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters for Naval SNF disposal containers have not yet been determined.

1.2.2.1.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. This criterion is in consideration of a fire event that is defined in "Packaging and Transportation of Radioactive Materials" (10 CFR 71), Section 73(c)(4).

Until a comprehensive analysis of fire hazards at the MGR is performed and establishes the credibility and/or magnitude of a design basis fire for the waste package, the hypothetical fire criteria for transportation casks, from 10 CFR 71.73(c)(4), is assumed. Therefore, this criterion remains to be verified.

The fire event is defined as exposure of the waste package fully engulfed in an average flame temperature of at least 800 degrees C (1,475 degrees F) for a period of 30 minutes, with an average emissivity coefficient of at least 0.9. For purposes of calculation, the surface absorptivity shall be either that value which the waste package may be expected to possess if exposed to the fire specified or 0.8, whichever is greater, and the convective coefficient shall be that value which may be demonstrated to exist if the waste package was exposed to the fire specified.

The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

This criterion is supported by Guidance Statements 6.7g2, 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb).

1.2.2.1.12 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C and 3.1.G. This requirement supports the criticality requirement from 10 CFR 63.112(e)(6) to the disposal container design during the preclosure period. The requirements for nuclear criticality safety as stated in "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste" (10 CFR 72), Section 124(a), are also directly supported by this criterion.

The general wording for this requirement is taken from "Nuclear Safety Criteria for Disposal Container System Description Documents" (Attachment 1, p. 2) (Input Transmittal RSO-RSO-99333.Tb). The reference provides input regarding Design Basis Events, therefore this requirement partially supports 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8).

This criterion is supported by Guidance Statements 6.12g1 and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The performance parameter for this requirement is taken from "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants" (p. 5).

During the preclosure period, the disposal container/waste package shall be designed such that nuclear criticality shall not be possible unless two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Conformance to the parameter basis must be met assuming occurrence of design basis events, including those with the potential to flood the disposal container prior to its sealing. Allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation for the calculated effective multiplication factor shall be justified in addition to conformance to the parameter basis.

1.2.2.1.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C. This criterion is a design screening component of the postclosure criticality methodology needed to ensure the expected annual dose to the critical group during the first 10,000 years after permanent closure does not exceed 25 mrem, as required by 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The criterion parameters are taken from "Transmittal of the Naval Nuclear Propulsion Program addendum to the Yucca Mountain Site Characterization Office 'Disposal Criticality Analysis Methodology Topical Report.'"

1.2.3.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.1.C. This requirement defines the external (outside of the waste package) environment for which the disposal container should be designed. 10 CFR 63.113(b) is traced because this considers the waste package influenced emplacement drift environment and its impact on the capability of the disposal container system to limit the expected annual dose to the average member of the critical group to 25 mrem at any time during the first 10,000 years after permanent closure of the repository.

Also, in consideration of MGR RD 3.4.2.C, this criterion defines the induced handling environment (credible loads) the disposal container/waste package must withstand.

II. Criterion Performance Parameter Basis

The microbe influx, colloid concentration, temperature, and radiation parameters are taken from "Performance Allocation Study Preliminary Results" (Table 4), which is the attachment to the input transmittal entitled "Manager System Requirements/System Description Documents." The pH, humidity, and water seepage parameters are taken from the "Monitored Geologic Repository Project Description Document" (Sections 5.2.25, 5.2.26, and 5.2.28). The induced handling environments are to be determined.

1.2.4.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required to comply with MGR RD 3.1.B and 3.1.G. This requirement is needed as an interface between the waste package and the Waste Emplacement/Retrieval

System to allow adequate waste package transporter shielding design for an acceptable dose rate at the external surfaces of the transporter (in support of "Standards for Protection Against Radiation" [10 CFR 20], Subparts A, B, and C). This requirement is not intended to yield disposal container design features that are added solely for the purpose of shielding (unshielded waste packages are recommended in the "Waste Package Size Study Report," p. 6-5), but is intended to establish the expected maximum dose rate the Waste Emplacement/Retrieval System will be designed to reduce.

This criterion is supported by Guidance Statements 6.12g1 and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Naval Spent Nuclear Fuel (SNF) Disposal Container."

II. Criterion Performance Parameter Basis

The maximum expected dose rate at all external surfaces of the waste package is to be determined.

1.2.4.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to comply with MGR RD 3.2.F. This criterion is required to comply with management direction put into effect via the "Monitored Geologic Repository Project Description Document," which places a constraint on the maximum heat output of individual waste packages. This criterion is also required to allow the design of the transporter used in the Waste Emplacement/Retrieval System. A maximum heat load criterion provides a bounding heat load that must be sustained by the transporter during emplacement operations.

II. Criterion Performance Parameter Basis

The maximum thermal output limit is obtained from the "Monitored Geologic Repository Project Description Document" (Section 5.2.13).

1.2.4.3 Criterion Basis Statement

I. Criterion Need Basis

This requirement establishes the amount of naval SNF to be disposed of in the repository. This requirement also supports MGR RD 3.1.A, 3.2.A, and 3.2.B.

II. Criterion Performance Parameter Basis

The approximate amount of naval SNF to be disposed of at the MGR is provided in "Information Requested By Yucca Mountain Site Characterization Office For Use in the Repository Environmental Impact Statement (EIS)" (Attachment 1, p. 7). The 65 MTHM is a portion of the maximum DOE owned SNF (2,502 MTHM) available to be disposed of at the MGR. The maximum amount is from MGR RD 3.2.B.

1.2.4.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to align disposal container design with surface repository disposal container handling operations.

II. Criterion Performance Parameter Basis

N/A

1.2.4.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to align disposal container design with surface repository disposal container handling operations.

II. Criterion Performance Parameter Basis

N/A

1.2.4.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the disposal container design accommodates welding and sealing equipment used by the Disposal Container Handling System and facilitates optimum welding times.

II. Criterion Performance Parameter Basis

N/A

1.2.4.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure mechanical interface consistency between the design of the disposal container and the naval SNF canisters. This is done by specifying the design be done in accordance with the interface agreements defined in "U.S. Department of Energy Spent Nuclear Fuel to the Monitored Geologic Repository for Mechanical and Envelope Interfaces," Volume 1 of "Integrated Interface Control Document."

II. Criterion Performance Parameter Basis

N/A

1.2.6.1 Criterion Basis Statement

I. Criterion Need Basis

In support of MGR RD 3.3.A, the "1995 ASME Boiler and Pressure Vessel Code" (Section III, Division 1, Subsection NG-1995) provides nuclear industry specific codes, standards and conformity assessment programs. ASME codes and standards are internationally recognized for the design, manufacturing and installation of mechanical devices. Requirements set forth in "Domestic Licensing of Production and Utilization Facilities" (10 CFR 50), Section 55 are specific in the use of ASME Boiler and Pressure Code as "quality standards commensurate with the importance of the safety function to be performed" (10 CFR 50.55(a)(1)).

II. Criterion Performance Parameter Basis

N/A

1.2.6.2 Criterion Basis Statement

I. Criterion Need Basis

In support of MGR RD 3.3.A, the "1995 ASME Boiler and Pressure Vessel Code" (Section III, Division 1, Subsection NB-1995) provides nuclear industry specific codes, standards, and conformity assessment programs. ASME codes and standards are internationally recognized for the design, manufacturing, and installation of mechanical devices. Requirements set forth in "Domestic Licensing of Production and Utilization Facilities" (10 CFR 50) Section 55 are specific in the use of ASME Boiler and Pressure Code as "quality standards commensurate with the importance of the safety function to be performed" (10 CFR 50.55(a)(1)).

II. Criterion Performance Parameter Basis

N/A

APPENDIX B ARCHITECTURE AND CLASSIFICATION

The QA classification as established in "Classification of the MGR Naval Spent Nuclear Fuel Disposal Container System" defines the overall system as QL-1. The next level of system architecture and assumed QA classification are identified in Table 10.

Table 10. System Architecture and QA Classification

System Architecture	QL-1	QL-2	QL-3	CQ
Naval SNF Disposal Container System *	X			
Naval SNF Short Disposal Container	X			
Naval SNF Long Disposal Container	X			

* Classification of the Naval Spent Nuclear Fuel Disposal Container System does not include the naval SNF canisters.

APPENDIX C ACRONYMS, SYMBOLS, AND UNITS

C.1 ACRONYMS

This section provides a listing of acronyms used in this document.

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BWR	boiling water reactor
CFR	Code of Federal Regulations
CQ	conventional quality
DHLW	Defense High-Level Waste
DBE	design basis event
DOE	U.S. Department of Energy
F	function
MGR RD	Monitored Geologic Repository Requirements Document
MGR	Monitored Geologic Repository
NG	nuclear grade
N/A	not applicable
NRC	U.S. Nuclear Regulatory Commission
PWR	pressurized-water reactor
QA	quality assurance
QL	quality level
SDD	system description document
SNF	spent nuclear fuel
SR	Site Recommendation
SS	stainless steel
TBD	to be determined
TBV	to be verified
TSPA	Total System Performance Assessment
UCF	uncanistered fuel
WP	waste package

C.2 SYMBOLS AND UNITS

This section provides a listing of symbols and units used in this document.

°C	degrees Celsius
°C/m	degrees Celsius per meter
F	Fahrenheit
g	acceleration due to gravity
cm	centimeter
ft	feet
hr	hour
in.	inches
kg	kilogram
km	kilometer
km/hr	kilometers per hour
kW	kilowatt
lb	pounds
m	meter
m/sec	meters per second
mg/ml	milligrams per milliliter
mi	mile
mm	millimeter
mrem	millirem
MPa	megapascals
MT	metric ton
MTHM	metric tons heavy metal
MTU	metric tons of uranium
N/m^2	Newtons per square meter
pH	hydrogen ion concentration potential
rem/hr	roentgen equivalent man per hour
sec	second
W/m-K	watts per meter-Kelvin
kW/m^2	kilowatts per square meter
μin	microinch
μm	micrometer
μm/yr	micrometers per year

APPENDIX D FUTURE REVISION RECOMMENDATIONS AND ISSUES

This appendix identifies issues and actions that require further evaluation. The disposition of these issues and actions could alter the functions and design criteria that are allocated to this system in future revisions to this document. However, the issues and actions identified in this appendix do not require TBDs or TBVs beyond those already identified.

D.1 Issue 1— Time to Disposal Container Breach and Subsequent Release Rate

Wording in current criteria should be revised to reflect a single value the disposal containers shall be designed for, without making reference to the performance of other waste packages and without involving probabilistic assessment of individual and collective waste package performance.

D.2 Issue 2—Label Legibility

Future criteria must consider observation by both human and electronic means. Also, the term "legible" must be described as the design of the waste package and surface facilities is further developed.

D.3 Issue 3— Disposal Container Lid Matching

The need for unique identification of the fabricated disposal container to a set of matched inner and outer lids needs to be investigated. If disposal containers will be matched to their lids, an identification system between the disposal container and its lids will be needed. The design criteria for such an identification will then need to be identified.

D.4 Issue 4— Handling Interface

The handling interface with the Disposal Container Handling System needs to be identified for empty disposal container handling, loaded disposal container handling, and lid handling.

D.5 Issue 5— Welding and Inspection Interface

The welding and inspection interface with the Disposal Container Handling System needs to be identified for inner and outer lid welding operations. This issue pertains to Criterion 1.2.4.6.

D.6 Issue 6— Inerting Interface and Operational Requirements

The filling of the container with an inert gas needs to be identified as an interface with the Disposal Container Handling System. Applicable disposal container requirements need to be determined.

D.7 Issue 7— Performance Allocation

Performance allocations for the waste packages to meet overall regulatory requirements need to be determined.

D.8 Issue 8— Postclosure Criticality

Postclosure criticality requirements will be determined for a future revision.

D.9 Issue 9— Corner Drop

In addition to vertical and horizontal drop, future study should include consideration of a "corner drop" of a waste package, from the design basis height onto both a pier and onto a flat surface, on the waste package design.

D.10 Issue 10— Waste Package Interaction

Performance criteria for "waste package – to - waste package" interaction during emplacement in the emplacement drift need to be studied.

D.11 Issue 11— Future Groundwater Standard

The anticipated groundwater standard to be issued by the Environmental Protection Agency must be addressed in a future revision.

D.12 Issue 12— Future Dose Limitations

The proposed 10 CFR 63 dose limit must be in agreement with the proposed EPA dose limit in a future revision.

D.13 Issue 13— Disposal Container/Waste Package Terminology

Use of the term "disposal container" vs. "waste package" must be evaluated and the document revised to incorporate the decision on terminology prior to Site Recommendation.

D.14 Issue 14— Clarification of Functions

The functions listed in Section 1.1 must be clarified prior to Site Recommendation. (The Naval Nuclear Propulsion Program suggests Functions 1.1.2 and 1.1.11, 1.1.4 and 1.1.12, and 1.1.8 and 1.1.13 contain redundancies. They also suggest Function 1.1.7 be clarified or removed.)

D.15 Issue 15— Update of the Design Description (Section 2)

Section 2 (Design Description) must be updated to reflect the future revision to the naval SNF disposal container design analysis.

D.16 Issue 16— Provide Definition of the Term "Protected" in Criterion 1.2.1.23

Update Criterion 1.2.1.23 and associated Criterion Basis Statement in Appendix A to define the term "protected." The definition will be included in the next revision of the document.

APPENDIX E REFERENCES

This section provides a listing of references used in this SDD. References list the Accession number or Technical Information Catalog number at the end of the reference, where applicable.

"1995 ASME Boiler and Pressure Vessel Code." The American Society of Mechanical Engineers. 1995 Edition. July 1, 1995. New York, New York: The American Society of Mechanical Engineers. TIC: 245287.

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